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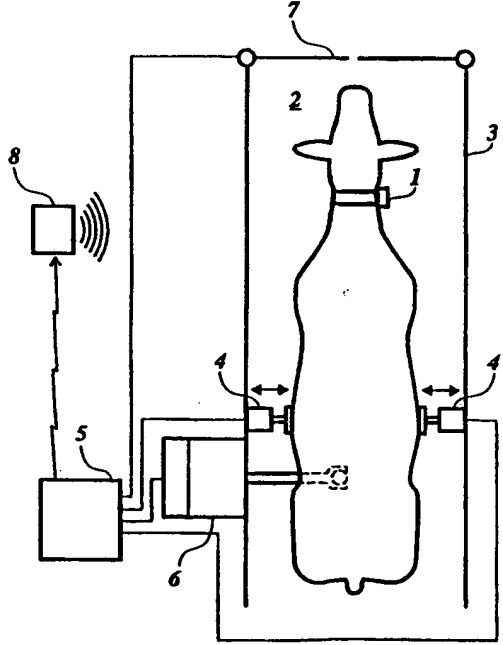
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁶ : A01K 29/00, A61B 5/11, 5/02, 5/08 // 5/113, A01K 11/00, 1/12</p>	<p>A1</p>	<p>(11) International Publication Number: WO 99/01026 (43) International Publication Date: 14 January 1999 (14.01.99)</p>
<p>(21) International Application Number: PCT/SE98/01305 (22) International Filing Date: 2 July 1998 (02.07.98) (30) Priority Data: 9702558-9 2 July 1997 (02.07.97) SE 9702559-7 2 July 1997 (02.07.97) SE (71) Applicant (for all designated States except US): ALFA LAVAL AGRI AB [SE/SE]; P.O. Box 39, S-147 21 Tumba (SE). (72) Inventors; and (75) Inventors/Applicants (for US only): HALL, Robert, Christo- pher [GB/GB]; 5 Gordon Court, St. Martins Road, Knebworth, Herts SG3 6DD (GB). SPENCER, Diane, S. [GB/GB]; 3 Hawk Close, Flitwick, Bedford MK45 1RX (GB). STREET, Michael, J. [GB/GB]; 34 Cutcliffe Grove, Bedford MK40 4DD (GB). (74) Agents: STEIN, Jan et al.; Albihs Patentbyrå Stockholm AB, P.O. Box 3137, S-103 62 Stockholm (SE).</p>	<p>(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, GW, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report.</p>	
<p>(54) Title: A METHOD AND AN APPARATUS FOR MONITORING AN ANIMAL</p> <p>(57) Abstract</p> <p>The invention relates to an apparatus and a method for monitoring an animal and having a control means (5). According to a first aspect of the invention, the control means (5) comprises a sensor means (4) adapted to sense movement of the animal and to establish a value of the movement regarding said animal. According to a second aspect of the invention, the control means (5) comprises a sensor means (4) provided to allow establishment of the existence of the breath of the animal, and a heart rate calculation means for establishing a value of the breathing rate regarding said animal.</p> 		

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A METHOD AND AN APPARATUS FOR MONITORING AN ANIMAL

TECHNICAL FIELD

- 5 The present invention relates to an apparatus and a method for monitoring an animal.

OBJECT OF THE INVENTION

- 10 Wherever a herd of cows is to be monitored - indoors or outdoors - there is a need for establishing the behaviour or the state of health of each cow. Generally, this is performed by the milker at each milking session. This, however, is not a very precise method, as an early stage of heat, a nervous behaviour, illness or diseases, such as BSE ("mad cow's disease") does not necessarily appear during milking session,
15 but during times of the day, when the milker is not present. Accordingly, there is a need for early establishment of an abnormal behaviour or state of health of the animal, especially at farms with large herds.

- It is, accordingly, an object of the present invention to provide a method and an apparatus for allowing monitoring of the animal in order to allow early establishment
20 of an abnormal state of health or an abnormal behaviour of the animal.

SUMMARY OF THE INVENTION

- 25 This has been solved by an apparatus of the initially defined kind, characterised in that it comprises a control means having a sensor means adapted to sense a movement of the animal and to establish a value of the movement regarding said animal, said control means being adapted to provide an output signal.
- 30 It has furthermore been solved by an apparatus of the initially defined kind, which is characterised in that it comprises a control means having a sensor means for allow-

ing establishing the existence of a breathing of the animal, and a heart rate calculation means for establishing a value of the breathing rate regarding said animal, said control means being adapted to provide an output signal.

5 It has also been solved by a method of the initially defined kind, which is characterised by sensing the existence of a breathing of the animal by means of a breathing sensor associated with a control means, and by establishing the breathing rate regarding said animal.

10 By the said apparatus and method, it is possible to promptly take care of an animal and perform appropriate actions.

Suitably, said control means is adapted to provide said output signal in case said value of the movement exceeds a predetermined level and not to provide said signal
15 in case said value of the movement does not exceed said predetermined level, in order to allow certain movement of the animal.

Alternatively, said control means is adapted to provide said output signal in case the said value exceeds a predetermined level and not to provide said signal in case said
20 value does not exceed said predetermined level.

Hereby, it is possible to determine or to set a limit to said value.

Preferably, the value of the movement rate is stored at a plurality of or at variable
25 occasions regarding said animal. Alternatively, the value of the breathing rate is stored at a plurality of or at variable occasions regarding said animal. Hereby, it is possible to more extensively monitor an animal suspected to behave in an abnormal manner.

30

Suitably, said control means is adapted to establish an average movement rate or an average breathing rate regarding said animal, outgoing from the stored values.

Hereby, a normal state of health or behaviour is possible to establish.

5

Preferably, said sensor means comprises a non-invasive sensor. Hereby, it is possible to sense the movement or the breathing of the animal without hurting it.

Such a sensor may be adapted to be held against a part of the animal's body, e.g. its belly and could be a tactile sensor.

Alternatively, said sensor means is adapted to be held at a distance from the animal's body, such as a laser sensor, an ultrasonic sensor, an ultrasonic distance meter, provided in the vicinity of the animal's belly, a microphone provided in the vicinity of the animal's head or a camera associated with said control means for allowing image processing of a received image.

Additionally, the apparatus comprises an animal related apparatus adapted to perform an animal related operation to an animal, said control means being associated with said animal related apparatus, wherein said animal related means is adapted to perform an action in response to said output signal.

Hereby, it is possible to control the animal related apparatus to perform a suitable action, if e.g. an abnormal behaviour or state of health of the animal is indicated.

Such action may be to at least suspend said animal related operation in case already started and not to initiate said operation in case not started.

Preferably, said animal related apparatus is an automatic milking apparatus comprising a robot arm for performing said animal related operation, said control means being associated with said robot arm. Accordingly, said animal related operation is

30

at least one of inspecting the teats, spraying the teats, cleaning the teats and attaching teatcups to the teats of the animal.

5 Suitably, said sensor is provided to sense an animal in an animal space, such as a milking stall, a feeding stall or a gateway provided with sideward limiting means.

10 Preferably, said animal space is provided with at least one gate, said control means being associated with said gate, and wherein said animal related operation is to open said gate for allowing the animal to leave the animal space. Hereby, it is possible to prevent an animal, which behaves in an abnormal way, from destroying e.g. the milking equipment or a robot arm.

15 Suitably, an identification means is provided, for allowing values of rates regarding an identified animal individual to be evaluated. Hereby, it is possible to monitor each animal individual of a whole herd.

20 Preferably, said control means is associated with an alerting means, to which the control means is adapted to send an output signal. Hereby, it is possible to promptly call for the milker by ringing a bell, a buzzer, sending a signal to a mobile telephone or via the Internet to a service man.

25 Suitably, said sensing means is adapted to provide a value of the distance of said movement. Alternatively, said sensing means is adapted to provide a value of the velocity of said movement. Alternatively, said sensing means is adapted to provide a value of the acceleration of said movement.

30 Preferably, said sensor means includes a time calculating means for establishment of time elapsed during the animal's movement. Hereby, it is possible to calculate an acceleration outgoing from the sensed values

Suitably, said sensor is adapted to sense the amplitude of said movement. Alternatively, or additionally, said sensor is adapted to sense the frequency of said movement. Hereby, it is possible to sense whether the animal moves violently or is shivering.

5

DRAWING SUMMARY

Figs. 1A and 1B are top views of a cow in an animal space provided with a tactile sensor means touching the body of a cow.

10

Fig. 2A and 2B are top views of a cow in an animal space provided with a sensor means sensing the body of a cow from a distance.

Figs. 3 is a top view of a cow in an animal space provided with viewing means for viewing the cow.

15

Fig. 4 is a top view of a breathing cow.

Figs. 5A and 5B are different views of a cow in an animal space provided with a microphone.

20

DETAILED DESCRIPTION OF THE INVENTION

Fig 1A. shows schematically a cow provided with a transponder 1 for allowing identification of the cow individual. The transponder communicates with a transmitter/receiver (not shown). The cow is in an animal space 2, such as a milking stall, a feeding stall or a gateway, defined at its sides by a sideward limiting means 3, such as a wall or a railing. According to a first embodiment, a movement sensor 4 in the form of a tactile sensor is provided on one side of the animal.

30

The tactile sensor 4 may be in the form of a hydraulic or pneumatic cylinder (also called air spring) provided with an extension measurement means connected to a control means 5.

- 5 The control means 5 calculates the movement rate by taking into account the time elapsed for each breath or a row of breaths.

A milking robot 6 is provided with a robot arm for cleaning the teats, attaching teat-cups etc., and is connected to the control means 5. A gate 7 is connected to the control means 5 to keep the cow in the stall or allow her to leave it.

10

An alerter 8 is connected to the control means 5, preferably, but not necessarily, wirelessly, so that the dairy maid can be made observant of an arisen extraordinary situation. The alerter may be a mobile telephone, a buzzer or a bell.

15

In fig. 1B, a pair of tactile movement sensors 4 connected to the control means 5 is provided for better resolution, as a pair of sensors 4 will increase the sensing accuracy.

- 20 Figure 2A shows an alternative sensor 4 for sensing the movement of the cow. The sensor 4 is associated with a control means 5. Such a sensor may be an ultrasonic distance meter sensing the time of flight of the sound waves, or a laser distance meter using a triangulation technique. In figure 2B, a pair of such breathing sensors 4 are provided for the same reason as in figure 1B.

25

- Fig. 3 shows yet an alternative movement sensor comprising a viewing means 4, such as a video camera or a digital camera. The viewing means 4 is connected to the control means 5, which contains an image analysing means. As is the case regarding the movement sensor described above, the control means 5 is arranged to control the movement of the robot arm and the opening and the closing of the gate 7.
- 30

In the following, a second embodiment of the invention will be described.

Fig 4. shows schematically a cow as seen from above. Rigid lines indicate the state
5 of her belly after exhalation, whereas the broken lines indicate the state of her belly
after inhalation. The difference in displacement of one side of the belly is indicated
at d .

What is described in connection with figures 1A, 1B, 2A and 2B is also applicable
10 to the second embodiment, however, with the following modifications.

The tactile sensor 4 shown in figure 1A is in this embodiment arranged to sense the
displacement d in order to establish an existing breathing of the cow. However, the
control means 5 instead calculates the breathing rate by taking into account the time
15 elapsed for each breath or a row of breaths.

The a pair of tactile sensors 4 of figure 1B is in this embodiment adapted, together
with the control means 5, to establish the total displacement $d + d = 2d$. A pair of
breathing sensors 4 will increase the sensing accuracy, as movement of the cow will
20 be possible to take into account.

The sensor means of figures 2A and 2B is used as a breathing sensor 4, which
senses the displacement d of the belly from a distance.

25 In fig 5A, a microphone 4 is arranged on the sideward limiting means 3, and is di-
rected towards the head, preferably the muzzle of the cow. The direction of the mi-
crophone may also be performed electronically. The microphone may be directed to
other parts of the cow, e.g. the belly. It is, of course, only possible to establish the
breathing rate, not the displacement d by means of the microphone.

30

In fig 5B, the microphone 4 is integrated with the transponder 1 in a common housing, attached to a collar to be worn by the cow. Of course, the microphone may be attached to a separate collar or to a common collar, but in a different housing.

- 5 The communication between the microphone and the control means is performed wirelessly.

OPERATION

- 10 A cow that enters an animal space 2 - there may of course be a plurality such animal spaces at a farm - will be identified in a usual manner by means of the transponder 1, when passing the not shown transmitter/receiver. The sensor 4 senses movement of the cow.

- 15 Regarding the breathing sensor embodiment, the sensor 4 senses the distance d corresponding to the difference in displacement of the belly of one side the cow.

The control means 5 calculates the movement rate at a plurality of occasions, such that an average value is possible to establish.

20

Whenever the control means 5 establishes that the movement rate (or the breathing rate and/or the displacement d differs from the average value, the control means 5 sends a signal in order to alert the milker - e.g. by ringing a bell or calling a mobile telephone. Alternatively, during attachment of teatcups by means of a milking robot

25 6, it may be that the cow runs into a state of panic. This will be apparent either by establishing an increased movement rate of the cow. The milking session may then be interrupted and restarted when the cow has calmed down. Alternatively, the cow may be let out from the milking stall by opening the gate 7.

30

It is important that if it is suspected or has been established that the cow acts in an abnormal way, it should be possible to check that cow more intensively. This may be performed either by not checking other "normal" cows each time it is identified
5 in order to allow the "abnormal" cow to be checked more often or by separating the cow to an area where more sensors are arranged.

Furthermore, in order to secure an abnormal behaviour or state of health, the control means 5 calculates the movement rate at a another plurality of occasions, such that a
10 new average value is to be established and can be compared to the average value of that cow at its normal state.

As an alternative to calculating an average value, it is, of course, possible to set a predetermined value, even though this would be less precise.

15 It should be noted that also other kinds of sensors may be used within the scope of the invention, such as inductive proximity sensors. Furthermore, the acceleration may be established by the provision of a pendulum or an integrated circuit with a piezo-electric sensor.

20 It should also be noted that the different kinds of sensors 4 described, may be used in combination to a so called sensor fusion, which creates an overall signal for increasing sensing accuracy.

25 Of course, the sensors may be situated in order to sense other parts of the animal than the belly, as shown in the figures.

Furthermore, it should be understood that the invention is not restricted to be used in connection with cows but with any milk animal, such as sheep, goats, buffaloes
30 and horses.

CLAIMS

1. An apparatus for monitoring an animal **characterised in that** it comprises a control means (5) having a sensor means (4) adapted to sense a movement of the animal and to establish a value of the movement regarding said animal, said control means (5) being adapted to provide an output signal.
2. An apparatus according to claim 1, wherein said control means (5) is adapted to provide said output signal in case said value of the movement exceeds a predetermined level and not to provide said signal in case said value of the movement does not exceed said predetermined level, in order to allow certain movement of the animal.
3. An apparatus according to claim 1 or 2, wherein the value of the movement rate is stored at a plurality of occasions regarding said animal.
4. An apparatus according to anyone of claims 1 to 3, wherein the value of the movement rate is stored at a variable occasions regarding said animal.
5. An apparatus according to claim 3 or 4, wherein said control means (5) is adapted to establish an average movement rate regarding said animal, outgoing from the stored values.
6. An apparatus for monitoring an animal **characterised in that** it comprises a control means (5) having a sensor means (4) for allowing establishing the existence of a breathing of the animal, and a heart rate calculation means for establishing a value of the breathing rate regarding said animal, said control means (5) being adapted to provide an output signal.

7. An apparatus according to claim 6, wherein said control means (5) is adapted to provide said output signal in case the said value exceeds a predetermined level and not to provide said signal in case said value does not exceed said predetermined level.
8. An apparatus according to claim 6 or 7, wherein the value of the breathing rate is stored at a plurality of occasions regarding said animal.
9. An apparatus according to anyone of claims 6 to 8, wherein the value of the breathing rate is stored at a variable occasions regarding said animal.
10. An apparatus according to claim 8 or 9, wherein said control means (5) is adapted to establish an average breathing rate regarding said animal, outgoing from the stored values.
11. An apparatus according to anyone of the preceding claims, wherein said sensor means (4) comprises a non-invasive sensor.
12. An apparatus according to anyone of the preceding claims, wherein said sensor means (4) is adapted to be held against a part of the animal's body, e.g. its belly.
13. An apparatus according to claim 12, wherein said sensor means (4) includes a tactile sensor.
14. An apparatus according to claim 12, wherein said sensor means (4) is adapted to be held at a distance from the animal's body.
15. An apparatus according to claim 12, wherein said sensor means (4) includes a laser sensor.

16. An apparatus according to claim 14 or 15, wherein said sensor means (4) includes an ultrasonic sensor.

5 17. An apparatus according to anyone of claims 14 to 16, wherein said sensor means (4) comprises at least one ultrasonic distance meter, provided in the vicinity of the animal's belly.

18. An apparatus according to claim 12, wherein said sensor means (4) comprises
10 a microphone provided in the vicinity of the animal's head.

19. An apparatus according to claim 12, wherein said sensor means (4) includes a camera associated with said control means (5) for allowing image processing of a received image.

15 20. An apparatus according to anyone of the preceding claims, wherein it comprises an animal related apparatus adapted to perform an animal related operation to an animal, said control means (5) being associated with said animal related apparatus, wherein said animal related means is adapted to perform an action in response to
20 said output signal.

21. An apparatus according to claim 20, wherein said control means (5) is adapted to at least suspend said animal related operation in case already started and not to initiate said operation in case not started.

25 22. An apparatus according to claim 20 or 21, wherein said animal related apparatus is an automatic milking apparatus comprising a robot arm for performing said animal related operation, said control means (5) being associated with said robot arm.

23. An apparatus according to anyone of claims 20 to 22, wherein said animal related operation is at least one of inspecting the teats, spraying the teats, cleaning the teats and attaching teatcups to the teats of the animal.

5 24. An apparatus according to anyone of the preceding claims, wherein said sensor is provided to sense an animal in an animal space (2), such as a milking stall, a feeding stall or a gateway provided with sideward limiting means (3).

10 25. An apparatus according to claim 24, wherein said animal space is provided with at least one gate (7), said control means (5) being associated with said gate (7), and wherein said animal related operation is to open said gate (7) for allowing the animal to leave the animal space (2).

15 26. An apparatus according to anyone of the preceding claims, wherein an identification means (1) is provided, for allowing values of rates regarding an identified animal individual to be evaluated.

20 27. An apparatus according to anyone of the preceding claims, wherein said control means (5) is associated with an alerting means (8), to which the control means (5) is adapted to send an output signal.

28. An apparatus according to anyone of the preceding claims, wherein said sensing means is adapted to provide a value of the distance of said movement.

25 29. An apparatus according to anyone of the preceding claims, wherein said sensing means is adapted to provide a value of the velocity of said movement.

30 30. An apparatus according to anyone of the preceding claims, wherein said sensing means is adapted to provide a value of the acceleration of said movement.

30

31. An apparatus according to anyone of the preceding claims, wherein said sensor means (4) includes a time calculating means for establishment of time elapsed during the animal's movement.

5 32. An apparatus according to anyone of the preceding claims, wherein said sensor is adapted to sense the amplitude of said movement.

33. An apparatus according to anyone of the preceding claims, wherein said sensor is adapted to sense the frequency of said movement.

10

34. A method of monitoring an animal, **characterised by** sensing the existence of a breathing of the animal by means of a breathing sensor (4) associated with a control means (5), and by establishing the breathing rate regarding said animal.

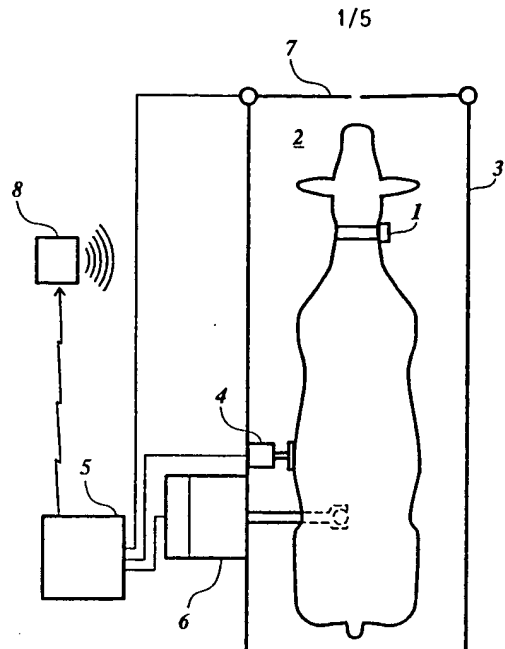


Fig. 1A

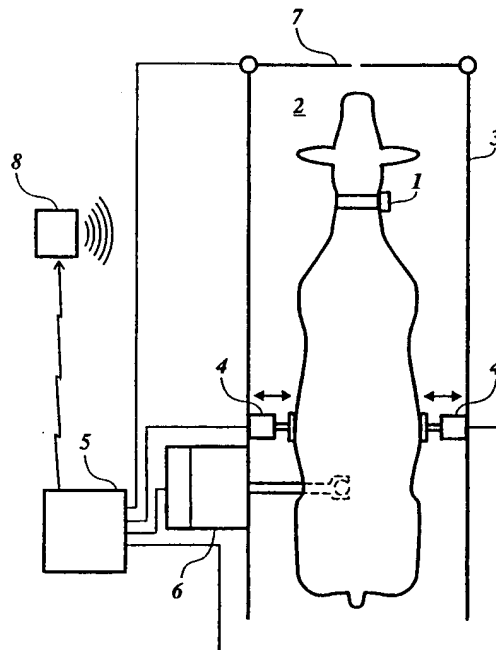
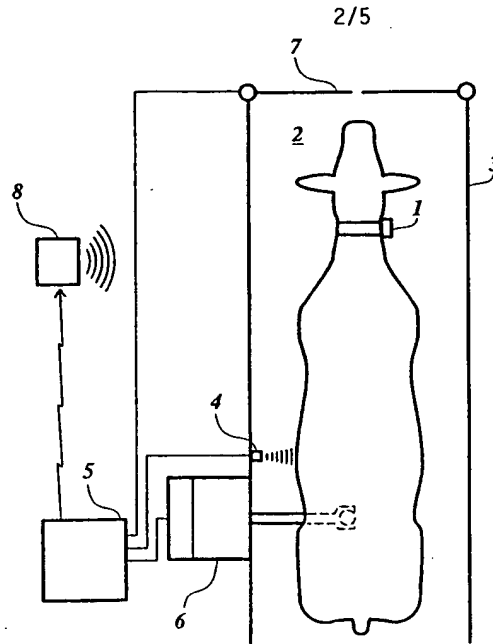
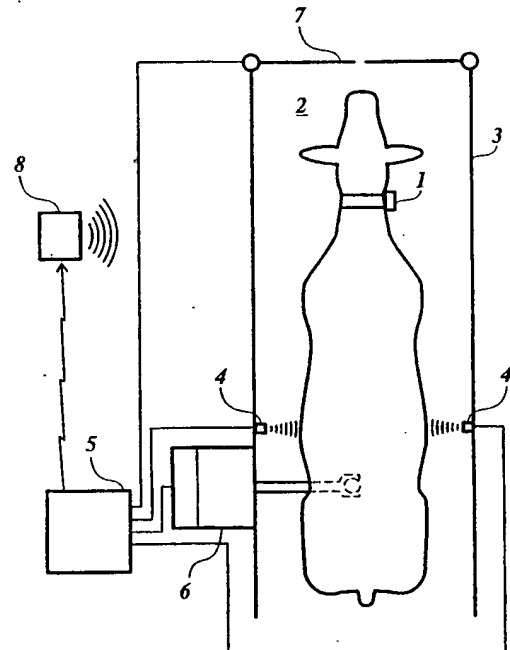
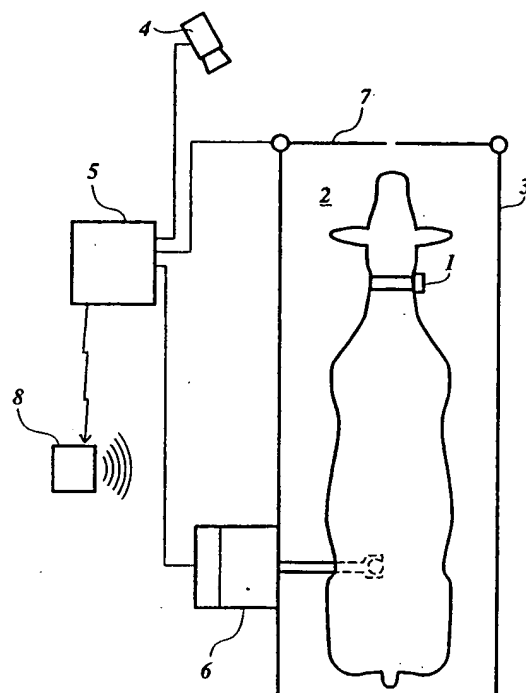


Fig. 1B

*Fig. 2A**Fig. 2B*

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*Fig. 3*

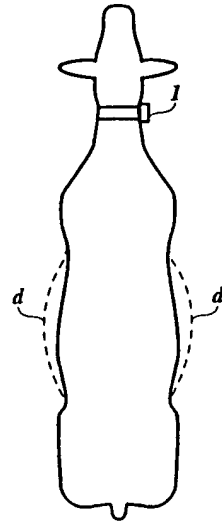


Fig. 4

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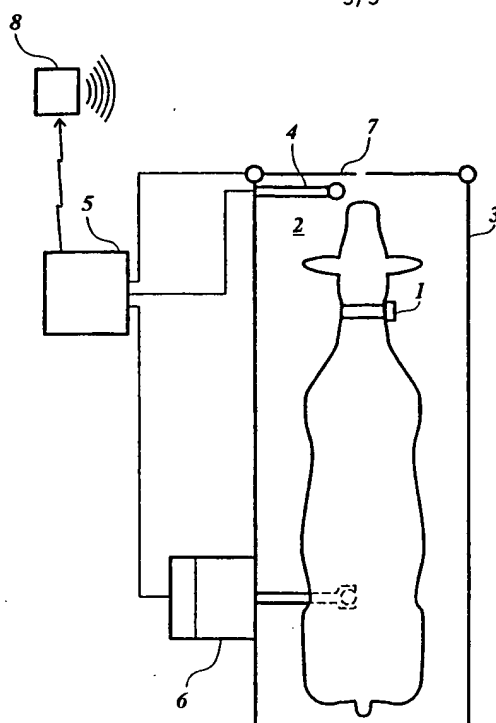


Fig. 5A

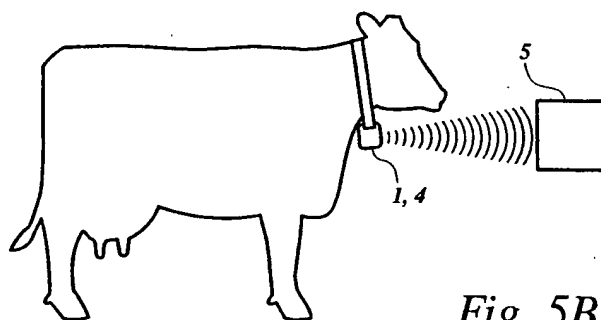


Fig. 5B

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/01305

A. CLASSIFICATION OF SUBJECT MATTER		
IPC6: A01K 29/00, A61B 5/11, A61B 5/02, A61B 5/08 // A61B 5/113, A01K 11/00, A01K 1/12		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SE 9504707 A (ALFA LAVAL AGRI AB), 30 June 1997 (30.06.97), page 5, line 31 - page 6, line 7, claim 1 --	1-5,11,12, 29-30,32-33
X	GB 2260196 A (MEDICAL SCIENTIFIC LTD), 7 April 1993 (07.04.93), figure 1, abstract --	1,3,4,11,12, 15,26,28,31, 33
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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0406978 A1 (N.V. NEDERLANDSCHE APPARATENFABRIEK NEDAP), 9 January 1991 (09.01.91), column 2, line 18 - line 31; column 2, line 52 - column 3, line 5; column 3, line 23 - line 37, figure 1 --	1,3,4,11,12,26
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01305

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/01305

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE97/01305

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE97/01305

The independent claim 1 relates to an apparatus adapted to sense movement of the animal. The independent claims 6 and 34 relate to an apparatus and a method for establishing the existence of 'a breathing' of the animal and a heart rate calculation means for establishing a value of the breathing rate. All the common features of claims 1, 6 and 34 are known in prior art. The application is considered to involve two different inventions represented by claim 1 and claims 6 and 34.

INTERNATIONAL SEARCH REPORT
Information on patent family members

27/07/98

International application No.
PCT/SE 98/01305

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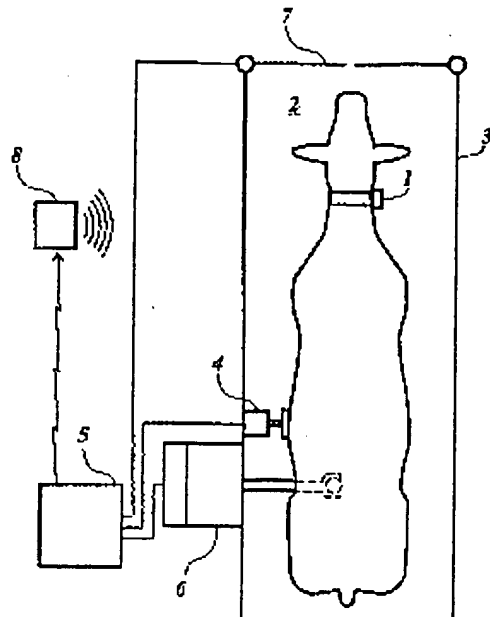


Fig. 1A

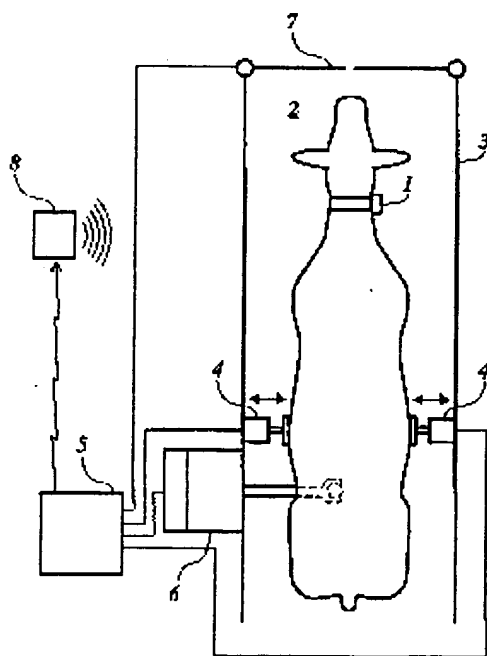
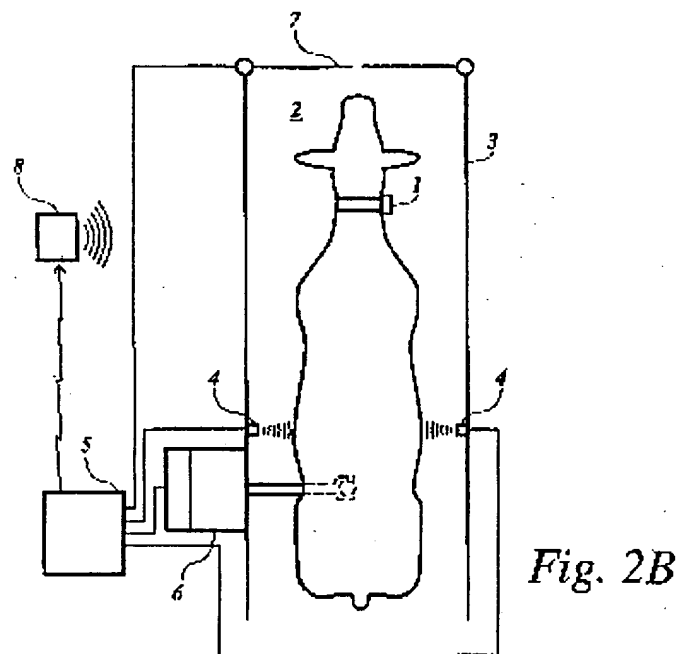
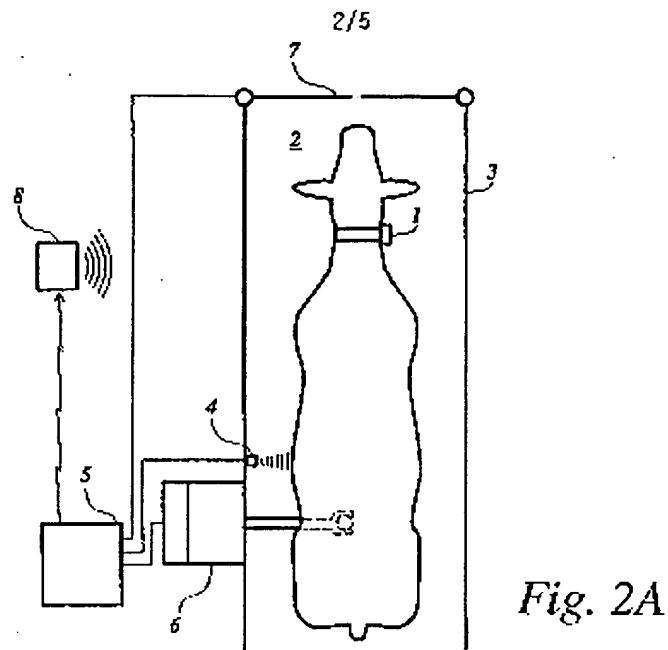
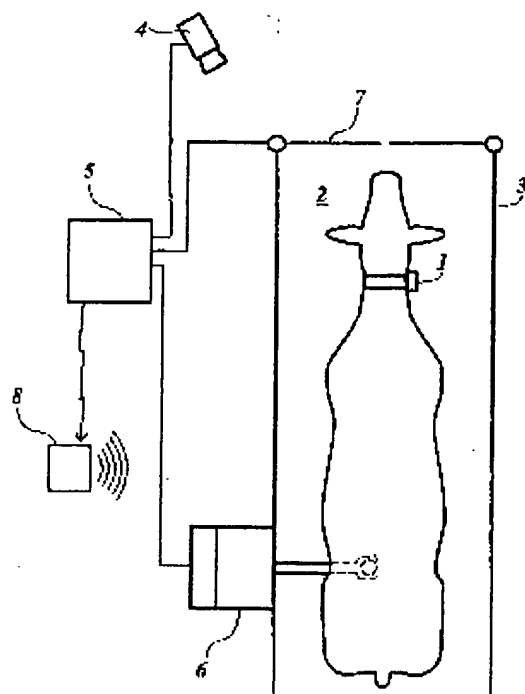


Fig. 1B



*Fig. 3*

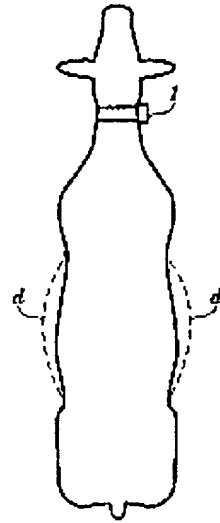


Fig. 4

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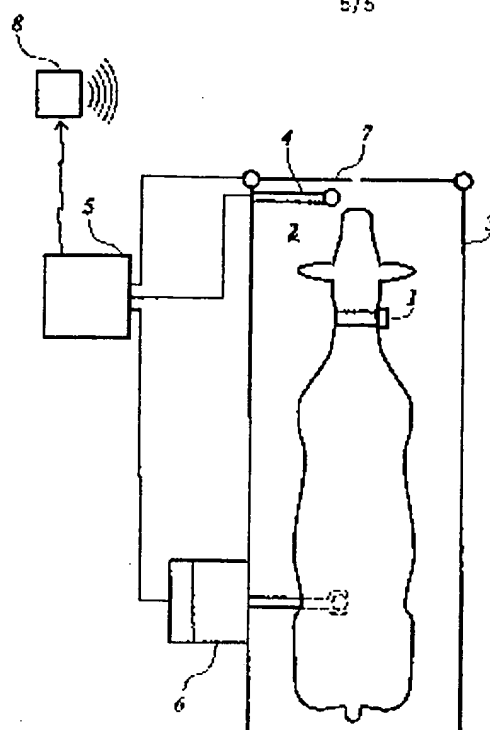


Fig. 5A

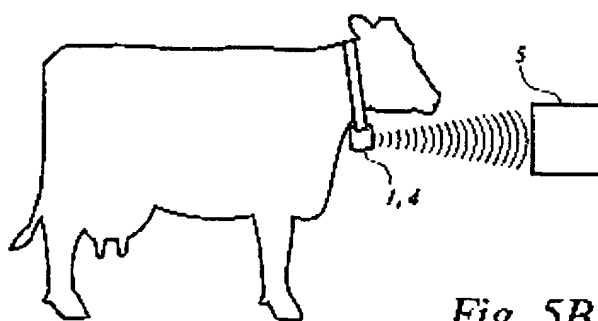


Fig. 5B